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# *Evolving Business Strategies to Utilize Development in Biotechnology Supporting Long-Term Production of Adequate Supplies of High-Quality Food for the World*

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In this paper I discuss agricultural biotechnology from an industry perspective, with reference to products and future trends, describing some of the new technologies and what they will mean to the farmer and to the industry as a whole.

In common with other companies, we at Monsanto realize the need to contribute to the feeding of two billion more people over the next 20 to 30 years, while respecting the environment. To rely on the methods of increasing food production that were used over the past two to three decades would be detrimental to the environment and, therefore, not sustainable in the long term. Moreover, we anticipate that increasing demands for improved food quality will influence what agricultural products reach the market place.

## CHALLENGES

Those are the challenges for agriculture, but what of the challenges for biotechnology? From an industry perspective, the state of affairs is more complex and less monopolistic than may be immediately apparent from the outside. For those who have invested in the area, there are complex issues related to patenting, for example. It is relatively easy for a small player to develop a significant patent that is required to deliver a new product to the market place. But, regulatory systems, which are still evolving worldwide, must be in place. For example, we were able to introduce new technology into Brazil only after a regulatory system was instituted there.

Consumer acceptance varies considerably from one part of the world to another. Currently, Europe is our biggest challenge and we do not expect to commercialize biotechnology products, including new crop varieties, there in the near future.

There is intense competition in getting biotechnology products to the marketplace, with investment of large sums of money necessary, much of it from other industries. The closest model, for the foreseeable future, is the electronics industry — incredibly rapid developments in technology and capability, with many players involved. I expect increasing competitiveness, a view not shared by everyone.

## CHANGES

During a recent visit to Boston, I asked one of our research laboratory leaders about changes in productivity, regarding the sequencing of genes of agricultural crops. Seven years ago, as a graduate student at a university lab, it took him a year to sequence one gene — extensive work and a great deal of hard labor. He pointed to one of a long row of instruments and said: “That machine will sequence 2,500 genes during this 24-hour period.” What took one person a whole year now can be done 2,500 times over in one day — and that row of machines is in operation 24 hours a day! It is likely that, for the major crops, the complete sequences of their 80,000 or more genes will be known within two years. Clearly, this is a time of great change in the biotechnology industry.

Around the world, government support for crop production is declining, a trend we expect to continue. Just as with industry, growers are consolidating to meet increasing demands for food. As biotechnology brings new opportunities, information is much more available today than it was even five years ago and growers are commensurately more sophisticated. To achieve higher yields, there is a significant shift in emphasis from the chemical inputs of the last decades to crop capability. For example, weed control was formerly limited to herbicide choices with quite distinct criteria involved in the selection of a seed variety. Now these decisions are interconnected — by planting soybean containing the Roundup Ready® gene, the farmer can apply a herbicide that could not previously be used on that crop. Until recently, the chemical, biotechnology, and seed industries were distinct, but this is no longer the case and food is just the next component. Food production, and the ability to improve food quality, will be dramatically affected by biotechnology.

By 2020, there will be about two billion more mouths to feed, largely as a result of population growth in the developing world. Over this time frame, the per capita Gross Domestic Product of the U.S. and Europe are expected to double, whereas those of China and India, for example, will increase five to six fold, bringing new financial capabilities. It is likely that improved quality of food will become a priority in Asia, with shifts in preference from cereal grains to meat and milk products, creating a total increase in demand for food of 75 percent over that for 1990.

## BIOTECHNOLOGY'S CONTRIBUTIONS

Let us consider India further. Increases in per capita consumption of milk and meat requiring more cereal grains will be comparatively higher in rural than in urban areas. Therefore, not only must we produce more food for the growing population, but satisfying demands for higher quality will necessitate increased productivity in excess of projections for population growth.

Increased needs for food must be met using farming practices that are sustainable. Of relevance are the new biotechnological tools for protecting crops from insects, weeds, fungi, and viruses. Products already on the market or in development include the following:

- Roundup Ready® corn provides new weed-control options for growers. More than two million acres were planted in the U.S. in 1999; it will be launched in a number of countries over the next two years.
- Corn protected from the European corn borer, is, essentially, a replacement for insecticides, although it is also planted by farmers who would otherwise not have sprayed because they could not properly time the spraying or achieve effective insect control. We are seeing a mean yield advantage of 13 bushels across the mid-west.
- A product in the pipeline for 2001 is corn protected from rootworm, a major pest. We have obtained dramatic effects: well over 99 percent control.
- Bollgard® cotton provides significant control of insects, saving farmers an average of approximately four sprayings, depending on location. In the mid-west, Roundup Ready® soybeans have received broad acceptance. In 1999, more than 50 percent of the U.S. soybean acreage was Roundup Ready®.
- Roundup Ready® rice is showing promise. It will give farmers a new weed-control option, and, in many places, will preclude the need to flood fields to kill weeds, presenting the opportunity to conserve water.
- Roundup Ready® wheat is expected to be available in 2003, and our data show great promise.
- Wheat with a protective gene remained healthy in laboratory tests after infection with head scab, a major disease in North America and Europe. These results promise reduced need for fungicide application, and significant yield benefits in parts of the world in which spraying is not an option.

A great deal of effort on the part of several companies is going into improving oil quality, with potential human-health benefits, and there are opportunities also to improve the seed-protein and oil values of corn to provide a better, more balanced livestock feed.

We have the ability to improve the starch content of potatoes. As french fries are cooking, the water is replaced by oil; the higher the starch content, the less oil in the finished product. So, for the fast food industry, fries with one-third less oil are possible, which, combined with improved oil quality, would be attractive to those concerned about fat and/or cholesterol. Although it would never be a recommended food, the product is more nutritionally sound, clearly, the permutations and capabilities now feasible present many new possibilities.

Lack of  $\beta$ -carotene in the diet results in night blindness and, ultimately, blindness for millions of people in developing countries. The technology exists to increase the  $\beta$ -carotene content of canola oil, which is used widely in India and China. It is hard for industry to justify investing in a product without the promise of a return on the investment. Through USAID, Monsanto found the opportunity to donate this technology to provide significant health benefits to people in many parts of the world. So I would argue that technologies developed by Monsanto will actually make it easier for other companies to introduce new products from minor crops to the market place.

## PLANTS AS FACTORIES

We believe that many products that have pharmaceutical value, will, in the future, be more economically produced in plants. Although farmers are excited about this, I do not foresee vast areas planted to pharmaceutical crops; however, the acres that are planted will be very valuable. While I believe the larger value for the farmer will accrue from grains with improved protein and oil quality for human consumption, the growing of crops with pharmaceutical applications will be increasingly important. Compounds produced by fermentation today will be produced in the future by moving the appropriate genes into plants.

## NEW CHOICES

Biotechnology will provide new choices for farmers. They will "vote" every year on whether to use the technology or not, which is the best competition of all. As mentioned above, conventional use of chemicals is being pre-empted by the choice of seed. The farmer will increasingly make decisions about pesticides through their purchase of seeds.

The cotton grower who would have had to spray three times, and possibly up to seventeen times in a single growing season, now can choose a product with which he is virtually assured that spraying will be necessary only once or twice, thus reducing personal exposure and environmental exposure.

We expect:

- greater production of value-added crops by contract,
- identity preservation of crops, if they have unique characteristics that have value,
- global competition, and
- intensification of farming and the farm-supply industries.

## KEYS TO SUCCESS

Success requires the right product in the right quantities at the right price. Most of the food products of biotechnology are substitutes for others that meet current demand. Ability to produce does not guarantee a market. Economical pricing is essential, and high quality and efficient production are important. By sharing value with people in the system, their participation is encouraged.

Monsanto has entered a joint venture with Cargill. Monsanto brings the technology and Cargill brings knowledge of end-uses and how to extend the system all the way to the consumer. Cargill also has the financial resources to help fund this expensive research, which takes six or seven years from project inception to the marketplace. Thus, by combining efforts and sharing costs, the risks involved in developing new products are shared. However, even when two such large entities combine, other players must be included in the collaboration because no two companies possess the wherewithal to invent all the necessary components or reach all the markets. Therefore, cross licensing of technology and capability, and product sharing will be increasingly common.

Monsanto has invested in seed companies because seed is critical for delivering the technology to the grower. For the same reason, DuPont has invested in Pioneer.

## GENOMICS

Having sequenced whole genomes, the next area of emphasis will be the linking of specific genes to phenotypes. Information in this area is already exploding, and the race is on to deliver new desirable traits to the market place.

We are excited because we currently use only about five percent of available corn races, whereas this technology will allow us to choose genes from any corn genotype, and other species of crops, and move specific desirable traits into commercial corn. With genomics, we could have brought Roundup Ready<sup>®</sup> soybeans to market two years earlier, and we will probably commercialize corn with rootworm protection two years earlier than initially projected.

Furthermore, in the past, it was necessary to grow out and test every line of soybean for a desired phenotype. We can now perform 10,000 tests per day to check for resistance to cyst nematodes, for example, for just 10 percent of the traditional cost. This efficient type of screening allows us to bring products more quickly and more efficiently to the market place.

## PATENT PROTECTION

In the U.S., newly commercialized products have patent protection, of which growers are aware. In many developing countries there is no such safeguard. In countries like India, the use of hybrids protects our technology — cotton for example. In China we have a trademark license that the Chinese support, and, in return, we provide seed of a quality higher than they have seen before. Likewise, in Poland, we provide better seed-potato quality than previously available.

Chinese cotton growers buy seeds in 1-kg quantities. Over 500,000 of them are planting our insect protected varieties on fields as small as a tenth of an acre. They are excited about reducing their pesticide applications and increasing the productivity of their family farms.

## QUESTIONS FOR THE FUTURE

I conclude with some questions.

- Can we help consumers worldwide understand the benefits of biotechnology?
- Will the benefits from biotechnology be shared appropriately with farmers?
- Will the rewards stimulate continued investment?
- Can appropriate linkages or networks be formed?
- How fast will demand for high-quality food increase?
- Can biotechnology help us to make increased production a more sustainable process?